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IS 3658 (1999): Code of practice for liquid penetrant flaw detection [MTD 21: Non-Destructive Testing]

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“Knowledge is such a treasure which cannot be stolen”



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भारतीय मानक

तरल बेधक द्वारा दोष संसूचन के लिए व्यवहार संहिता
(दूसरा पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR LIQUID
PENETRANT FLAW DETECTION
(*Second Revision*)

ICS 19.100

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Liquid penetrant processes are non-destructive testing methods for detecting discontinuities that are open to surface. They may be effectively used in the inspection of both ferrous and non-ferrous metals and on non-porous, non-metallic materials, such as ceramics, plastics and glass. Surface discontinuities, such as cracks, seams, laps, cold shuts and laminations, are indicated by these methods. Flaw detection with the help of liquid penetrant is being increasingly used in various industries in the country and recommendations of a general character providing guidance on the applications of these methods are considered necessary. The recommendations made in this code are based on accepted current practice, and are intended to serve as a guide for carrying out the test satisfactorily.

This standard was first published in 1966 and was subsequently revised in 1981. In this revision, definitions of a number of new terms have been included.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CODE OF PRACTICE FOR LIQUID PENETRANT FLAW DETECTION *(Second Revision)*

1 SCOPE

1.1 This standard covers the recommended procedures for flaw detection by the application of liquid penetrants.

1.1.1 This standard does not lay down any stipulation for the acceptance or rejection of materials and components on which flaws have been detected. This shall be subject to mutual agreement between the contracting parties.

2 REFERENCE

The following Indian Standard is a necessary adjunct to this standard:

<i>IS No.</i>	<i>Title</i>
12889 : 1989	Performance evaluation of liquid penetrants

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Aerosol Spraying

Delivery of liquid or suspensions of the particles in a liquid form from a pressurized container.

3.2 Air Accelerated Spray

Liquid in the form of a spray accelerated by compressed air.

3.3 Air/Water Spray Gun

A spray gun of ventury type, using compressed air to deliver water as a pressurized spray.

3.4 Angstrom Unit Å

A standard unit for measuring wave-length of electromagnetic radiation.

3.5 Anti-Coagulants

Agents which prevent the separation and agglomeration of the dispersed phase from an emulsion, dispersion or colloidal solution.

3.6 Background

The surface of the test part against which the indication is observed.

3.7 Background Coloration

The unwanted coloration remaining after removal of dye-penetrant on the surface.

3.8 Background Fluorescence

The unwanted fluorescence remaining after incomplete removal of a fluorescent penetrant from the surface.

3.9 Black Light

Electromagnetic radiation in the near ultra-violet radiation (3 300-3 900 Å) used for fluorescence.

3.10 Black Light Filter

A filter that transmits near ultra-violet radiation (3 300-3 900 Å) while absorbing other wave length light.

3.11 Bleed-Out

The action of entrapped liquid penetrant in coming to the surface from discontinuities to form indications.

3.12 Blotting

The action of the developer in soaking up the penetrant from the surface of the discontinuities to accelerate bleed out to the surface of a material.

3.13 Capillary Action

The property of certain liquids to penetrate when exposed to small openings such as cracks or fissures.

3.14 Carrier Fluid

A fluid which acts as a carrier for active materials.

3.15 Carry-Over Penetrant

The transfer into the rinse tank of the penetrant remaining on the parts.

3.16 Clean Test Piece

Free of contaminations so as not to affect the quality.

3.17 Comparative Test Block

An intentionally cracked metal block having two separate zones of similar fine cracks for comparison of different penetrants.

3.18 Contaminant

Any foreign substance present on the test surface or in the inspection materials which will adversely affect the performance of liquid penetrant materials.

3.19 Contact Time

The time allowed for the penetrant to seep in or penetrate into the flaws.

3.20 Contrast

The difference in visibility between an indication and the background.

3.21 Corrosion Inhibitor

A substance that minimizes corrosive attack.

3.22 Defect

A discontinuity or group of discontinuities whose indications are unacceptable as per specifications.

3.23 Degreasing Fluid

Agents employed to remove oil and grease from the surface of components before the penetrant process.

3.24 Detergent Remover

A penetrant remover that is a solution of a detergent in water.

3.25 Developer

A material that is applied to the test surface to accelerate bleed-out and to enhance the contrast of indications.

3.26 Developer Dry

A direct in the form of fine free flowing powder.

3.27 Developer Liquid Film

A suspension of developer particles in a vehicle which leaves a resin/polymer film on the test surface after drying.

3.28 Developer Soluble

A developer completely soluble in its carrier not a suspension of powder in a liquid, which dries to an absorptive coating.

3.29 Developer Wet (Aqueous) Suspensible

A suspension of developer particles in water.

3.30 Developer (Non-aqueous)

Suspension-particles of developer suspended in a non-aqueous medium before application to test surface.

3.31 Developing Time

The time between the application of the developer and subsequent examination of the part.

3.32 Dip Rinse

A means of removing excess penetrant in which the test parts are dipped into an agitated tank of water or remover.

3.33 Discontinuity Surface

An interruption in the physical structure or configuration of the part may be either intentional or unintentional.

3.34 Drag Out

The carry-over or loss of penetrant material as a result of their attachment to the test pieces.

3.35 Drain Time

The portion of the dwell time during which the excess penetrant or emulsifier drain from the part.

3.36 Drying Oven

An oven used for increasing the evaporation rate of rinse water or an aqueous developer vehicle from test parts.

3.37 Drying Time

The time required for a rinsed or wet developer test parts to dry.

3.38 Dwell Time

The total time that the penetrant or emulsifier is in contact with the surface of the part — including the application and drain time.

3.39 Dye Penetrant

A penetrating liquid, used for flaw detection, containing dyes (usually deep red) intended for viewing in normal light.

3.40 Electrostatic Spraying

A technique for obtaining a uniform coating in which the material sprayed is given an electrical charge.

3.41 Emulsifiable Penetrant

Penetrants capable of being converted to a water washable condition by the addition of emulsifiers.

3.42 Emulsifier

An agent, usually in liquid form which when combined with a liquid penetrant that is insoluble in water renders such a penetrant soluble, thereby facilitating its removal by water wash.

3.43 Emulsification Time

The time that an emulsifier is permitted to remain on the part to combine with the penetrant prior to removal, also called emulsifier dwell time.

3.44 Emulsifier Hydrophilic

A water based liquid in penetrant examination which interacts with the penetrant oil making it water washable.

3.45 Emulsifier Lipophilic

An oil based liquid used in penetrant examination which interacts with the penetrant oil rendering it.

3.46 Evaluation

A review, following interpretation of the indications noted to determine whether or not they meet the specified acceptable criteria.

3.47 False Indication

An indication obtained through improper technique or processing.

3.48 Family

A complete series of penetrant material from a single origin/source required for the performance of the liquid penetrant examination.

3.49 Flash Point

The lowest temperature at which a substance will give off sufficient vapour to flash momentarily on the application of a small flame.

3.50 Flaw

Same as discontinuity.

3.51 Fluorescence

The emission of visible radiation by a substance as a result of, and only during the absorption of black light radiation.

3.52 Fluorescent Penetrant

Penetrating liquids containing additive to give fluorescence under black light.

3.53 Foot Candle

The illumination on a surface, 1 ft² in area, on which is uniformly distributed a flux of 1 lm (lumen). It equals 10.8 lm/m².

3.54 Immersion Rinse

A method of removing surface penetrant by immersing the test part in a tank containing water or suitable remover.

3.55 Indication

It is the presence of detectable bleed-out of liquid penetrant.

3.56 Inspection

Visual examination of the test after completion of the liquid penetrant processing steps.

3.57 Interpretation

Determination of the indication whether they are relevant or non-relevant.

3.58 Leak Testing

A variant method of liquid penetrant testing wherein the penetrant is applied to one side of a material and observation is made on the opposite side to ascertain the presence or absence of discontinuities extending through the section thickness.

3.59 Non-relevant Indications

Indications resulting from a condition not associated with a material discontinuity.

3.60 Oil and Chalk Process

A process employing oil as penetrant and chalk as developer.

3.61 Over Emulsification

The removal or penetrants from some discontinuities due to excessive emulsifier dwell time.

3.62 Overwashing

Removal of penetrants from discontinuities either due to too long or too vigorous washing, or both.

3.63 Penetrant

A solution of dye, either visible or fluorescent, capable of entering into discontinuities open to the surface.

3.64 Penetrant Remover

Any means employed to remove excess penetrant from the surface.

3.65 Penetration Time

The time allowed for the penetrant to seep in or penetrate into flaws.

3.66 Penetrant Comparator

An intentionally made flaw specimen having separate but adjacent areas for the application of different liquid penetrant materials to compare their relative effectiveness and it can also be used to evaluate liquid penetrant techniques, liquid penetrant system of test condition.

3.67 Penetrant Dual Purposes

A penetrant that produces both fluorescent and colour contrast visible indications.

3.68 Penetrant Fluorescent

A penetrant that emits visible radiation when excited by black light.

3.69 Penetrant, Post Emulsifier

A liquid penetrant that required the application of a separate emulsifier to render the excess surface penetrant water washable.

3.70 Penetrant, Solvent Removable

A liquid penetrant so formulated that most of the excess surface penetrant can be removed by wiping with a lint free cloth lightly moistened with applicable solvent.

3.71 Penetrant Visible

A liquid penetrant that is characterized by an intense colour, usually red and is visible under normal light.

3.72 Penetrant Water Washable

A liquid penetrant with a built in emulsifier.

3.73 Penetrant Indication

Same as 'Indication' (see 3.55).

3.74 Penetrant Material

The penetrant material used shall meet the requirement specified in IS 12889.

3.75 Pooling

The existence of excessive amounts of emulsifier or developer in an incompletely drained area.

3.76 Post Cleaning

The removal of developer or other penetrant inspection materials, or both, from the item being inspected, after the inspection operation.

3.77 Post Emulsification

The technique of removing the penetrant by employing a separate emulsifier.

3.78 Procleaning

The removal of surface contaminants from the test so that they will not interfere with the examination process.

3.79 Proemulsifiable Penetrant

A penetrant with suitable emulsifying agents added

to make it directly water washable.

3.80 Quenching of Fluorescence

The extinction of fluorescence by causes other than the removal of the exciting radiation.

3.81 Reference Pieces

Specimens containing controlled artificial defects or material defects, used for checking the efficiency of penetrant flaw detection process.

3.82 Relevant Indication

An indication from a discontinuity requiring evaluation.

3.83 Replenishers

Materials added to compensate for the loss of particular constituents to a penetrant during use.

3.84 Rinse

The process of removing liquid penetrants from the surface of part by water, etc.

3.85 Self-emulsifiable

The property of a liquid penetrant to combines satisfactorily with water, thus facilitating its removal by washing with water.

3.86 Soak Time

Time for which emulsifier remain in contact with liquid penetrant over the surface of part. It is synonymous with emulsification time.

3.87 Solvent Remover

A solvent penetrant remover employed for removal of excess surface penetrant from parts or for removal of unwanted background porosity indications.

3.88 Tempering Envelope

The temperature range over which a particular penetrant inspection test will operate.

3.89 Through Penetration Technique

It is synonymous with leak testing.

3.90 Ultra Blue Light

Monochromatic blue light of approximately 4 300 Å wave length, used to cause certain liquid penetrants to fluoresce.

3.91 Vapour Degreasing

The removal of oils, greases and organic oils by the use of suitable vapour.

3.92 Vehicle

A liquid, either aqueous or non-aqueous, in which liquid penetrant examination materials are dissolved or suspended.

3.93 Viscosity

The property of a fluid that presents a resistance to shearing flow.

3.94 Visible Dye Penetrant

An intensely coloured highly penetrating liquid which will provide maximum contrast with the white developer when used for detection of surface flaws.

3.95 Visible Light

Electromagnetic radiation in the spectral range of 4 000-7 000 Å wave length.

3.96 Wash

Same as 'Rinse' range (see 3.84).

3.97 Water Tolerance

Amount of water that a penetrant or emulsifier can absorb before its effectiveness is *impaired*.

3.98 Water Washable Penetrant

A penetrant containing emulsifying agents to render itself emulsifying to facilitate its removal by water rinsing.

3.99 Wet Dip Developer

A suspension of finely divided developer particles in a liquid medium suitable for dipping application.

3.100 Wet Spray Developer

A suspension of finely divided developer particles in a liquid medium suitable for application by a spray.

3.101 Wetting Agents

The ability of a liquid to spread over and adhere to solid surfaces.

4 PRINCIPLE OF TEST

A suitable liquid penetrant is applied to the surface of the component under examination and is permitted to remain there for sufficient time to allow the liquid to penetrate into any defects open at the surface. After the penetrant time, the excess penetrant, which remains on the surface, is removed. Then a light coloured, powder absorbent called a developer is applied to the surface. This developer acts as a blotter and draws out a portion of the penetrant which had previously seeped into the surface openings. As the penetrant is drawn out, it diffuses into the coating

of the developer, forming indications of the surface discontinuities or flaws (see Fig. 1 to 4).

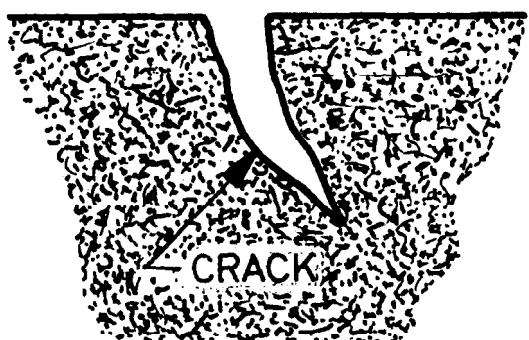


FIG. 1 CLEANED SURFACE

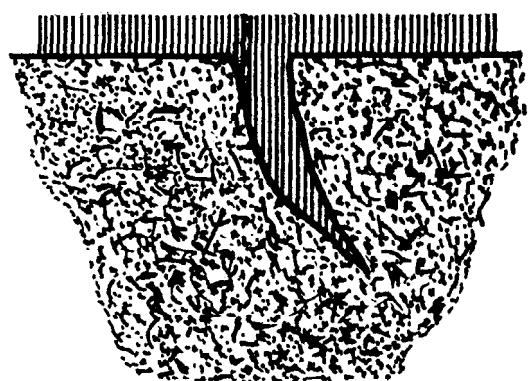


FIG. 2 PENETRANT COVERED

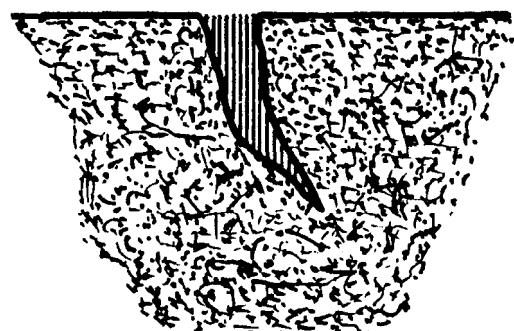


FIG. 3 EXCESS PENETRANT REMOVED

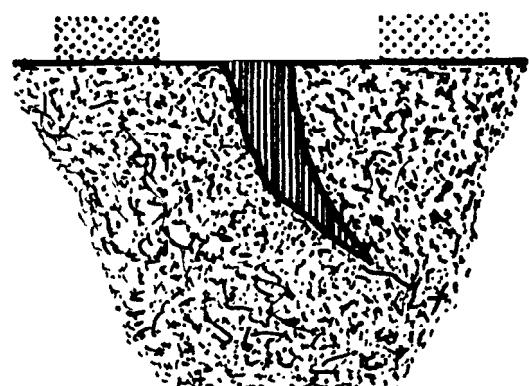


FIG. 4 DEVELOPER APPLIED

5 TYPES OF PENETRANT

5.1 The penetrants may be broadly classified into three basic categories:

- a) *Thin Oil Penetrant* — Like kerosene oil.
- b) *Colour Contrast Penetrant* — Those which are highly contrasting under units light. These are generally of deep red or similar shade.
- c) *Fluorescent Penetrant* — Those which fluoresce under black light.

5.2 According to the manner in which the penetrants are removed from the surface of the components under test, they may be classified into the following three types:

- a) Water washable, which are removed from the surface of the components under test by washing with ordinary tap water;
- b) Those which are removed by special solvents; and
- c) Post emulsifying, which are not in themselves water washable, but may be made so by applying an emulsifier as an extra step after the penetration is completed. During a short emulsification period, this emulsifier blends with the excess penetrant on the surface of the part, after which it is easily removed by water spray. In case of water washable penetrants, the emulsifying agent is already mixed in the penetrant, making them readily washable by a spray of water.

6 SELECTION OF PENETRANTS

6.1 Use of thin oils like kerosene oil in conjunction with chalk as developer is suitable only for the preliminary inspection of rough castings. It is not recommended for finished parts.

6.2 Both the colour contrast and fluorescent penetrant methods are more sensitive than the oil and chalk method. The water washable type of penetrant suffer from three distinct disadvantages from the stand point of effective detection of very fine defects. First, the emulsifier present in the penetrant tends to reduce the penetrability of penetrants. Secondary, it reduces the amount of fluorescent material which can be dissolved in the penetrant. Thirdly, being easily washable, they are likely to be washed off from shallow defects. Therefore, the post-emulsifiable penetrants are preferred for the critical examination of components where high sensitivity is required. Since the penetrant in the crack or open defect does not come into contact with the emulsifier, water washing does not remove the excess penetrant from the discontinuities, but takes it off from the surface. Penetrants removal by special solvents are as good as post emulsifying penetrant.

6.2.1 The fluorescent penetrants have greater visibility for the detection of fine defects, but these are not recommended for use on rough surface; such

as sand castings, because of the difficulty to remove the excess penetrant. Water washable fluorescent penetrants may be used on sand castings with rough surfaces.

7 TEST PROCEDURE

7.1 Generally the detailed instructions of the manufacturers of the penetrants should be followed if available at the time of carrying out inspection. Manufacturers provide adequate instruction on the method of application of their process. These instructions prescribe:

- a) the temperature range within which the penetrant fluid is effective and also the temperature of the component being inspected at the time of penetrant application,
- b) the solvent or cleaning material to be used for the removal of excess penetrants, and
- c) the intervals of time which should elapse between each successive operation in the process.

7.2 Surface Preparation

7.2.1 In general satisfactory results can be obtained when the surface is in the as welded, as rolled, as cast, or as forged condition but surface preparation by grinding or machining or other method may be necessary in some instances when surface irregularities could otherwise mask indications of unacceptable discontinuities. Heavy grinding should be avoided to avoid the masking of fine defects. However, any mechanical working leaning should be followed by suitable etching.

7.2.2 The surface to be examined and all adjacent areas within at least 25 mm should be dry, free from any dirt, lint, grease, welding flux, weld spatter, oil, or other extraneous matter that could obscure surface openings or otherwise interfere with the examination. The method of cleaning depends on the nature of the material of the part and contaminants. Typical cleaning facilities make use of detergents, organic solvents, descaling solutions, alkali solutions, paints removers, vapour degreasing, ultrasonic cleaning, abrasive blasting, etc. Blasting with shots or dull sand is permissible only when it does not peen over or fill the voids, as this drastically reduces the accuracy of the inspection.

7.2.3 Drying

It is essential that parts be thoroughly dried after cleaning so that no water or solvent remains in or over the discontinuities, as this will hinder entrance of the penetrant. Drying may be accomplished by warming the parts with infrared lamps, drying ovens, forced air circulation, etc.

7.3 Penetrant

7.3.1 After the part has been thoroughly cleaned, apply the penetrant to the surface to be inspected.

In case of small components, they may be dipped in a tank of penetrant. Where only a local area of a component is to be tested, the penetrant may be applied by a brush or spray. Regardless of how it is applied, it is important that all surfaces are wet by the penetrant.

7.3.2 The length of penetration time is critical and depends upon the type of material being inspected, type of penetrant, kind and size of defect anticipated together with the temperature of the penetrant.

7.3.2.1 In the standard testing temperature range of 15-60°C, and using post emulsified/solvent removable penetrants, a minimum of 10 minutes shall be allowed as standard penetration time; and for cracks with specially narrow widths, twice the time given above should be allowed.

7.3.2.2 If water washable penetrants are used, the penetration time shall be about 1.5 to 2.0 times of that stated in **7.3.2.1**.

7.3.2.3 When a high viscosity fluorescent penetrant is used, the penetration time may be longer than the normal penetration time. In such a case, time shall be subject to agreement between the manufacturer and the purchaser.

7.3.2.4 If the testing is to be done out of the range of 15-50°C, the penetration time should be suitably modified and the whole process and materials be checked using a comparator block described in **8.2**. If necessary the penetrant should be applied repeatedly so as to ensure that it has not dried. One half of the block shall be tested at the temperature at which testing is intended.

7.3.2.5 An extremely, long penetration time does not affect the results except to increase the brilliance of indications slightly and make removal of the excess penetrant more difficult.

7.4 Rinsing

7.4.1 After allowing for necessary penetrant time, the surface film of penetrant on the part is removed by rinsing. The rinsing must be thorough and complete so that the penetrant within the discontinuities of the part alone is intact. Special attention should be given to drilled holes and threads, which are highly prone to retain penetrant.

7.4.1.1 Using water washable penetrant, rinsing should be done with water spray nozzle. The temperature and mains pressure of rinsing water should not exceed 43°C and 3 kg/cm², respectively, otherwise water may remove some of the penetrant from larger or shallower discontinuities. The distance between the nozzle and the part should be not less than 300 mm and the angle of spray should be 45° to the wash surface for ideal results. The water droplet from the nozzle should be spray type rather than pointed.

7.4.1.2 Using post emulsifying penetrants, an

additional step is required. This is the application of a liquid emulsifier prior to rinsing operation. The emulsifier may be applied by spraying or dipping. The emulsifying time is critical and depends on the type of emulsifier surface roughness and types of defects sought. It may vary from 10 seconds to 5 minutes. The usual time is 2 to 3 minutes. After emulsification, the mixture is removed by a water spray, using the same procedure as for water washable liquid penetrant.

7.4.1.3 While using solvent removable penetrants, care should be taken not to use while excess of the solvent to avoid removal of penetrants from defects.

7.4.1.4 On smooth surfaces, it may be possible sometimes to remove excess penetrant merely by wiping the surface with clean dry lint free rags.

7.4.1.5 Using fluorescent type of penetrant, it is helpful to use portable black light source, while rinsing, so as to ensure that rinsing operation is complete. Rest of the procedure is same as outlined for dye penetrants.

7.4.1.6 The piece after removal of excess penetrant should be dried with the help of dry lint free cloth, by normal evaporation method at ambient temperature and/or by application of low pressure compressed air at a temperature not exceeding by 50°C.

7.5 Developing

7.5.1 After washing off the surface penetrant in the rinsing operation, apply developer to the part to blot back to the surface any penetrant that may have penetrated into discontinuities. Developers are either of dry type or wet type.

7.5.2 Dry developer is a powder and can be applied by dipping the part in powder chamber, a hand powder bulb, a tower gun or in a dust storm chamber after drying the part by warm air or hot air circulation oven. Oven temperature should not exceed 110°C and the part surface temperature should not exceed 55°C.

7.5.3 Wet developer is a suspension of powder in water or a volatile solvent. It is applied by dipping or spraying and should be agitated before use to ensure uniform dispersal of solid particles in the carrier fluid. When the developer dries, a film of powder is left on the surface. Where a water suspension developer is used, drying time may be decreased by the use of warm air, or by keeping in hot air oven as per procedure mentioned in **7.5.2**. Thick coatings and pools of wet developer may result in marking of indications, and shall be avoided.

7.5.4 Developer, whether dry or wet, shall be applied as soon as possible after removal of the excess penetrant.

7.5.5 A developing time should be allowed before final inspection of the part to allow the developer to bring back to the surface the penetrant that may be in discontinuities.

Excessively long developing time of around 10 min is generally adequate may cause the penetrant in large deep discontinuities to bleed profusely, making a broad, smudgy indication and making appraisal of true size and type of defect difficult. A good practice is to start observation as soon developer is applied.

8 INSPECTION

8.1 With visible dye penetrants, surface defects are indicated by bleeding out of penetrant, which is normally of deep red colour, against white background. Adequate illumination of 400 to 800 LUX of white light (500 LUX can be obtained by 80 watts of day light fluorescent tube at 1 meter/100 watts tungsten filament lamp at 0.2 metres distance) should be provided.

8.2 With fluorescent penetrants, inspection is carried out in a darkened area using high intensity black light, whereby indications fluorescence brilliantly. A portable hand lamp should be used over the surface of large parts. Small parts are conveniently viewed under a fixed light. Adequate black light for inspection is obtained by using a 100 watt mercury vapour bulb of the sealed reflector type and a special filter which filters out most of visible light. Black light intensity of 800-1 000 microwatt/cm² as measured by a black light meter placed in the position of job is adequate. The operator should allow his eye to become accustomed to the darkness of the inspection booth before inspecting the part. Black light (wave length 365 ± 15 mm) is injurious to the skin and eyes and hence viewing of black light shall be avoided. It would be further desirable for the operator to wear protective spectacles when using black light.

8.3 Usually a crack or similar opening will show a line and tight crack or a partially welded lap will show a broken line. Gross porosity may produce large indications covering an entire area. Very fine porosity will be indicated by random dots.

8.4 When an indicated pattern has appeared, the evaluation must be made to ascertain if the pattern is attributed to the actual flaw or an apparent one.

8.5 Depth of surface discontinuities may be correlated with the richness of colour and speed of bleeding. Wiping the first layer of developer and immediately spraying the second coat may help in judging the depth of flaw by observing speed and intensity of second bleeding.

8.6 Retest must be done from cleaning stage in case if any error in procedure was noticed, or when a difficulty was found to ascertain whether the indicated pattern is due to actual flaw or an apparent one.

8.6.1 A surface which has been treated with a colour contrast penetrant shall not subsequently be processed with any other fluorescent penetrant unless the job has been thoroughly cleaned, since residuals may react with fluorescent penetrant resulting in complete or partial quenching or fluorescene.

8.7 The nature, size, type and location of defects shall be recorded.

8.8 Post Cleaning

Thorough cleaning of test pieces shall be carried out after inspection to ensure that no corrosive action takes place on the same due to penetrant chemicals.

9 CONTROLS

9.1 The liquid penetrant system should be periodically checked to ensure they are efficient, maintained within prescribed concentration ranges and are free of excessive muddiness or sedimentation.

9.1.1 The manufacturers of liquid penetrant systems shall specifying the expiry dates in each case on the containers of the penetrant cleaner and developer.

9.2 The efficiency of dye penetrant may be checked by the use of specimens known to contain defects or by means of parts with artificial defects. One way to prepare test blocks is to take a 75 mm × 50 mm × 12 mm bar of duralumin. The block is heated to above 525°C over a burner, the heat being applied to the centre of the block. When the requisite temperature is reached the block is immediately quenched in cold water. This causes cracks to be formed on the block. 'Repeated heating on alternate faces and subsequent quenching is needed to cause cracks' after the words 'formed on the block'. The block is then moderately heated to drive off water and a cut is made on either face of the block at the centre with a band saw. While comparing two penetrants materials or techniques, the slot provides the means of avoiding intermixing of samples under test.

9.2.1 The same block or test specimens should not be used repeatedly because the cracks gradually get filled up with the developer and it will be difficult to restore to original condition even with effective cleaning procedure.

9.3 Apart from the comparator block mentioned above, set of nickel chrome test panel can also be used. This consists of a set of 3 nickel chrome panels, namely 'Coarse', 'Medium', and 'Fine' having surface cracks of varying dimensions. The coarse test panel is designed for testing of visible dye penetrants and low performance fluorescent penetrants, the medium test panel for high performance visible dye penetrants and for medium performance fluorescent penetrants while the fine panel is for high performance fluorescent penetrants.

10 LEAK TESTING BY LIQUID PENETRATION

10.1 The testing of materials for flaws that extend completely through the section is termed 'leak testing'. Obviously the absence of flaw indications does not preclude the presence of extensive flows that are however not completely through the material. Leak test carried out as recommended in this procedure

cannot be substituted for pressure test, where the applied stress and the associated proof test factors are significant. Method is advantageous as it can be used on sub-assemblies prior to the completion of finished container.

10.2 Penetrant Application

Any of the penetrants as detailed in **5** and **6** may be used. Penetrant should be applied in such a way that entire surface is covered with penetrant, at the same time penetrant should not reach the opposite surface by passing around edges or holes. Penetrant should be applied in sufficient quantity.

10.3 Developing

Just after applying penetrant, apply developer on the surface opposite that upon which the penetrant was applied. Any suitable developer as outlined in **7.5** may be used. Developer should not be allowed to reach the surface on which penetrant has been applied.

10.4 Penetration Time

Exact penetration time is determined by trials only. However, initial trials period shall not be less than three times of the time given in **7.3.2**. In general, penetration time varies with the thickness of the section under examination.

10.5 Viewing Test Results

Test indications shall be viewed after the completion

of penetration time. The illumination on system shall be as specified in **8.1** and **8.2**.

10.6 Interpretation of Test Results

When using the penetrant inspection technique for leak testing, the interpretation shall be restricted to citing the presence or absence of leak flaws and, when present, the general nature (holes, crack, etc), magnitude, and location of the flaws.

11 REPORT OF EXAMINATION

The results of the liquid penetrant test shall be reported covering information on:

- a) identification/Reference of construction and weld,
- b) testing media and cleaning operation,
- c) penetration and developing time,
- d) description and locations of relevant indications,
- e) deviations if any, adopted from the provisions of this Indian Standard,
- f) manufacturer's name/code of penetrant chemicals, and
- g) name of operator and competency level.

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